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THE PRESENCE OF A PERITROPHIC MEMBRANE IN SOME AQUATIC HEMIPTERA

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Although the peritrophic membrane was formerly believed to be absent in the order Hemiptera, Sutton (1951) has reported its presence in at least two species of Corixidae. It appears now that a peritrophic membrane is present in a second cryptocerate family, the Nepidae.

In a recent study on the digestive system of water bugs, the author made serial sections through the midguts of 29 adult specimens of *Ranatra fusca* P.B. Of these, four individuals showed evidence of what might be interpreted as a peritrophic membrane. In two of the four, the membranous material was found throughout the midgut; one of these is shown in Figure 1. In a third, it was limited to the anterior dilated portion of the midgut, while in the fourth specimen it was present only in the narrow posterior region of the mesenteron.

The membrane appeared to be of the type which is secreted by the midgut epithelium in general (the Type I of Wigglesworth, 1950) rather than by a limited group of cells. In most sections it seemed to be formed by the condensation, in the lumen of the gut, of a network of fine strands of cuticula, secreted by the midgut cells. In some areas, however, the membrane, which varied in width from one to approximately four micra, appeared to be delaminated directly from the surface of the epithelium.

In the two individuals which showed this structure throughout the midgut, it was not a continuous membrane.

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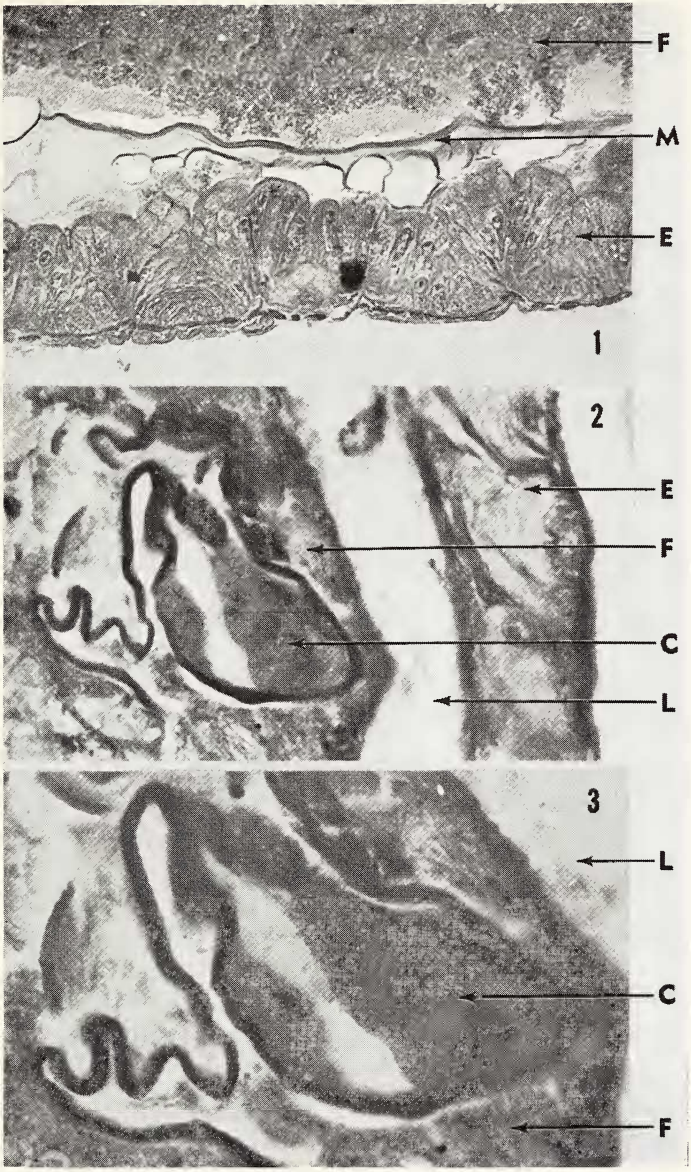
Its presence in a region seemed, in general, to be correlated with the presence of food in that region, and not all the midgut cells appeared to be secreting it. This gave it a fragmentary appearance in most sections.

In order to ascertain whether the membrane contained chitin, and could be called a peritrophic membrane, eight midguts of *Ranatra* which had been fed fifteen hours before were subjected to the chitosan test, as described by Richards (1951, pp. 32 and 33). Solid food was never observed in the *Ranatra* midgut, and thus use of this test seemed to be justified. The technique of Sutton (personal communication) was employed; each individual was dissected in Ringer's solution, the gut removed, and the midgut cut off just posterior to the esophageal valve and anterior to the point of entrance of the Malpighian tubules. The midgut was then placed in about 5 cc. of concentrated potassium hydroxide solution in a Bunsen tube and heated in a glycerine bath to 160 degrees C. for 20 minutes. If, after this treatment, any residue remained in the tube, it was tested with Lugol solution, zinc chloride, 1% sulfuric acid, and 3% acetic acid, following the methods prescribed by Richards (1951). In three of the eight individuals, positive reactions were obtained by this method; the small and very delicate strands of material which remained after the potassium hydroxide treatment in these three appeared, therefore, to be chitinous in nature, and to represent fragments of a peritrophic membrane.

Explanation of Plate 9

Figures 1-3. Fig. 1. Longitudinal section through part of the anterior, dilated portion of the midgut of *Ranatra fusca,* showing the secretion of a peritrophic membrane by the epithelial cells. Fixed in alcoholic Bouin's; Mallory's triple connective tissue stain. 240 X. Fig. 2. Longitudinal section through the posterior part of the midgut of *Hesperocorixa interrupta.* Note the large fragment, presumably an ingested piece of arthropod exoskeleton, within the food mass. Fixed in aqueous Bouin's; Mallory's triple connective tissue stain. 440 X. Fig. 3. Detail of the fragment shown in Figure 2. Note the sculpturing on the surface of the fragment. 720 X.

Abbreviations Used in Figures. C-Fragment of exoskeleton within food mass. E-Midgut epithelium. F-Food material in gut. L-Lumen of gut. M-Peritrophic membrane.



Parsons — Peritrophic Membrane of Hemiptera

The peritrophic membrane of *Ranatra* bears some resemblances to that of *Sigara falleni* and *Corixa punctata* as described by Sutton (1951). Both were of Wigglesworth's Type I, fragmentary in nature, and seemed to be secreted in response to the presence of food; both were present in only a few of the individuals examined. Sutton found the peritrophic membrane only in the posterior part of the midgut, however, whereas that of *Ranatra* may occur throughout the mesenteron.

The author has examined several species of North American corixids, representing the genera *Hesperocorixa, Sigara,* and *Trichocorixa,* to determine whether any of these possessed a peritrophic membrane. Histological sections through the midguts of ninety corixids showed no evidence of a membrane. The midguts of ninety-nine others, all of which contained food, were removed and examined in a dish of Ringer's solution under a stereoscopic microscope; they were carefully turned inside out, beginning at the posterior end, with fine forceps. Since the epithelium tended to curl outwards when peeled back in this way, its inner surface and the surface of the midgut's contents could be easily examined for traces of a membrane. However, none of the midguts so examined showed anything of this sort. The two species of which the most individuals were examined were *Hesperocorixa interrupta* (113) and *Sigara signata* (22) ; the present study has shown, therefore, that a peritrophic membrane is absent, or at least extremely rare, in these species.

Sutton applied the Schulze and chitosan tests to whole midguts, using the technique which was described earlier in this paper. She considers the chitosan test to be the most reliable, and describes her method as follows: "I did not dissect out the membrane. Instead I dissected out the hind part of the mid gut taking great care that no trace of the oesophageal valve was present (to avoid any invalidation of the results of the tests to be applied, by the chitinous 'entonnoir'.) The chitosan and Schulze tests were then applied to the freshly dissected mid guts. I did not apply any test for chitin to preserved material" (Sutton, personal communication).

It is unfortunate that the chitosan test cannot be applied to sectioned material. However, Sutton's technique is open to criticism. The corixids, unlike *Ranatra*, are able to ingest particulate food, and histological sections through their midguts often show sizeable fragments of exoskeleton from small Crustacea and other arthropods within the food mass (Pl. 9, Figs. 2 and 3). The presence of setae or surface sculpturing on these fragments indicates that they are of foreign origin rather than secretions of the midgut epithelium. The chitin in these pieces could withstand potassium hydroxide treatment as well as could a peritrophic membrane, and it seems unlikely that the former could be distinguished from the latter, using Sutton's technique.

To test this hypothesis, the chitosan method was applied to the midguts of eighteen *Hesperocorixa interrupta*, using Sutton's technique. In one of these, a positive result was obtained. A small piece of material, approximately 0.5 mm. square, withstood the potassium hydroxide treatment and reacted positively to the subsequent tests. Examination of this fragment under the compound microscope showed it to be rolled up like a scroll, its surface covered with small hairs. It bore much resemblance to the pieces seen in histological sections through the food mass in corixids.

In the author's opinion, the chitinous nature of the "membranelles" described by Sutton in the midguts of two species of corixids has not been sufficiently proven. Some test must be devised which can distinguish between secreted and ingested chitin before this point can be settled. However, the discovery of a peritrophic membrane in *Ranatra*, in which ingested particles have never been observed, supports Sutton's conclusion that this structure is not absent in the Hemiptera. It may be, as she has suggested, that the Type I membrane is a primitive feature which has been inherited from the ancestral hemipteran. It seems quite possible that further study will reveal its presence in other species of the Hemiptera.

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